Rutting Performance Tests for Airport Asphalt Mixture Design

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Problem Statement

- A need exist to adopt a laboratory rutting performance test for airport HMA mixture design to accompany a new specification based on gyratory compaction

Background

- Gyratory HMA mixture design methods adopted by state DOTs in the 1990s
- Airport HMA mixture design historically centered around Marshall manual compaction. Gyratory compaction option added 21 July 2014
- New regulations allow heavier loads and higher tire pressure for each category of aircraft traffic. Volumetric properties for mixture acceptance may not be sufficient to design for these standards
- No performance test for gyratory mixture design has been widely adopted

Objective

- Identify a laboratory procedure for testing HMA designed for airfield pavement that can identify mixtures prone to rutting

Research Approach

- Subject selected HMA mixtures to suite of potential performance tests
- Establish performance testing acceptance thresholds based on laboratory data
- Validate performance thresholds using range of HMA mixtures and binder grades

HMA Mixtures

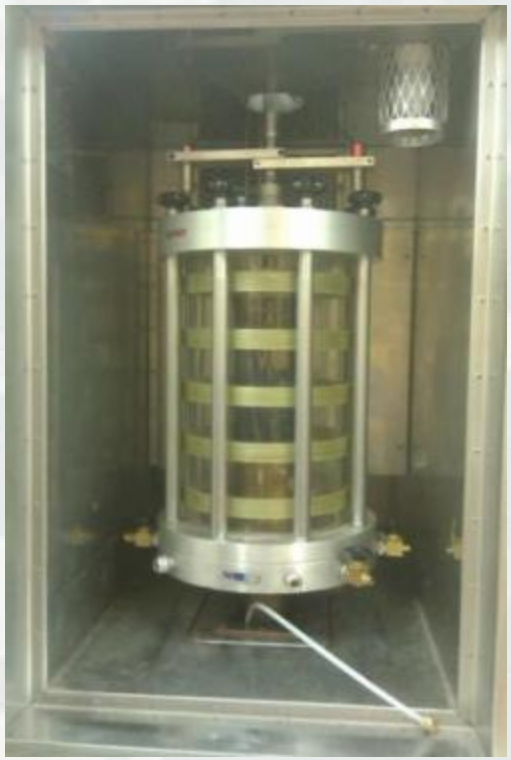
- Phase 1
  - Limestone, Granite, and Chert Gravel aggregates
  - Various gradations and natural sand dosages
  - 26 mixtures with PG 64-22 binder
  - 8 mixtures with PG 76-22 binder
- Phase 2
  - Aggregates sourced from plants producing mixtures for paving at NAPTF, Columbus AFB, and Boston Logan International and from Granite Mountain Quarry, AR
  - 6 mixtures, each with 6 binders
  - 2 base grades with 2&3 grade “bumps”

Selected Performance Tests

- Flow Number
  - Confined uniaxial repeated loading
- Flow Time
  - Confined uniaxial static loading
- Indirect Tensile Strength
  - Compression using Lottman breaking head
- Asphalt Pavement Analyzer
  - Simulative wheel tracking test

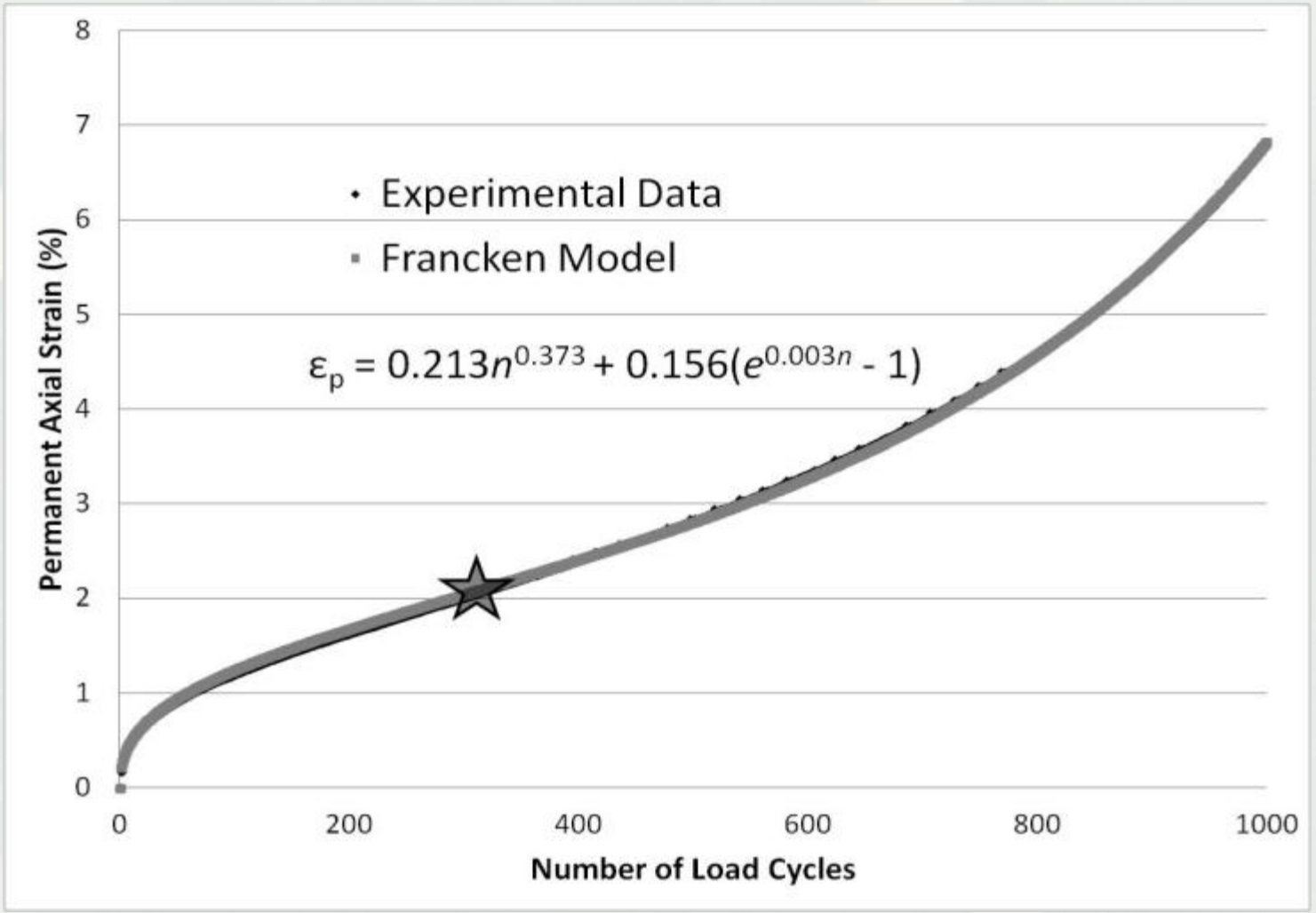
Repeated Load

- Permanent Deformation versus Number of Load Cycles
  - 0.1 s pulse, 0.9 s rest
  - Confining pressure = 40 psi
  - Axial stress = 200 psi
  - Temp = T_{eff} (43°C or 37°C)
  - Francken model fit to data



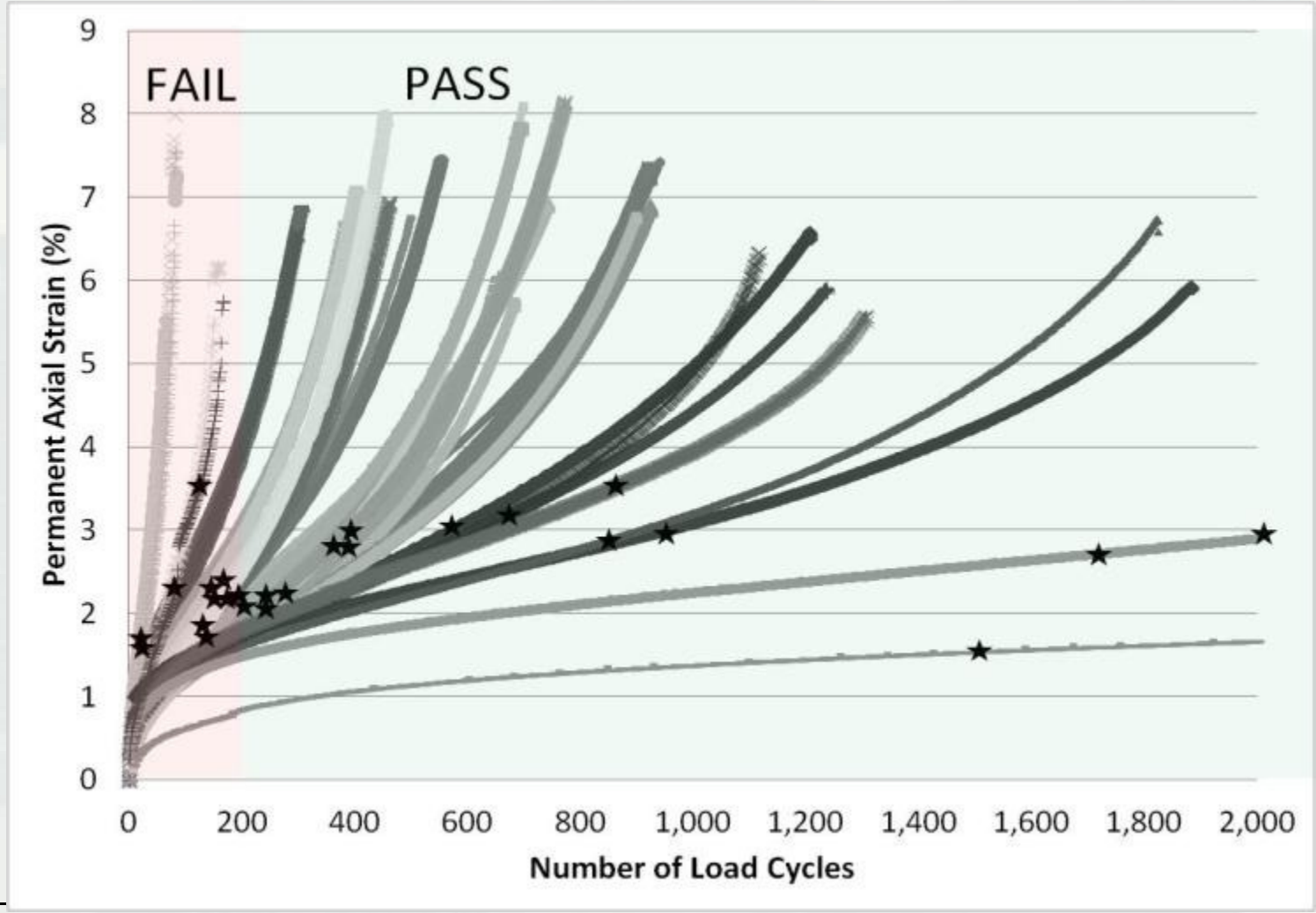
$$\varepsilon_p = An^B + C(e^{Dn} - 1)$$

Example Repeated Load Data



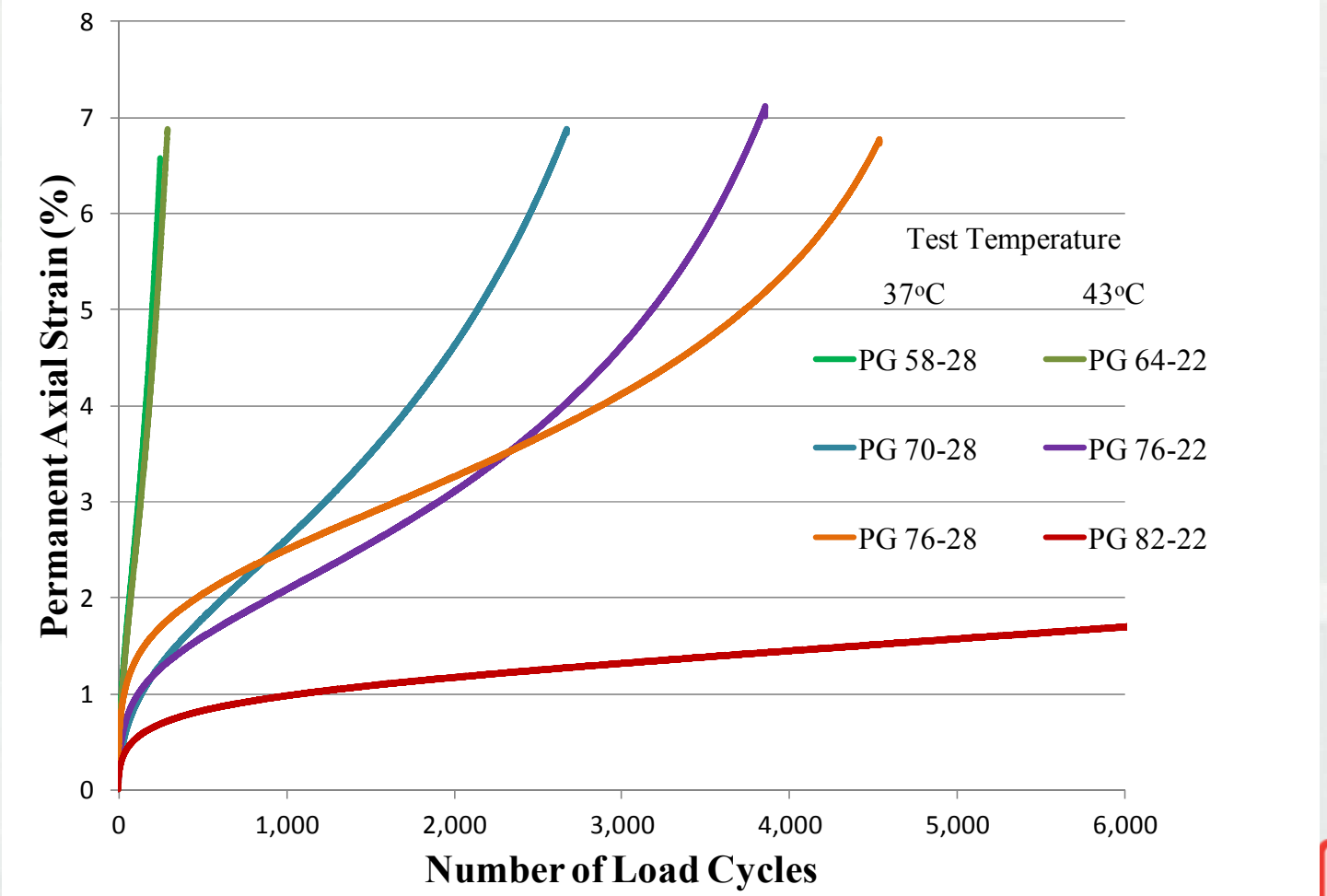
Example Criterion for Flow Number

Phase 1 Results



Influence of Binder on Flow Number

Example from Phase 2

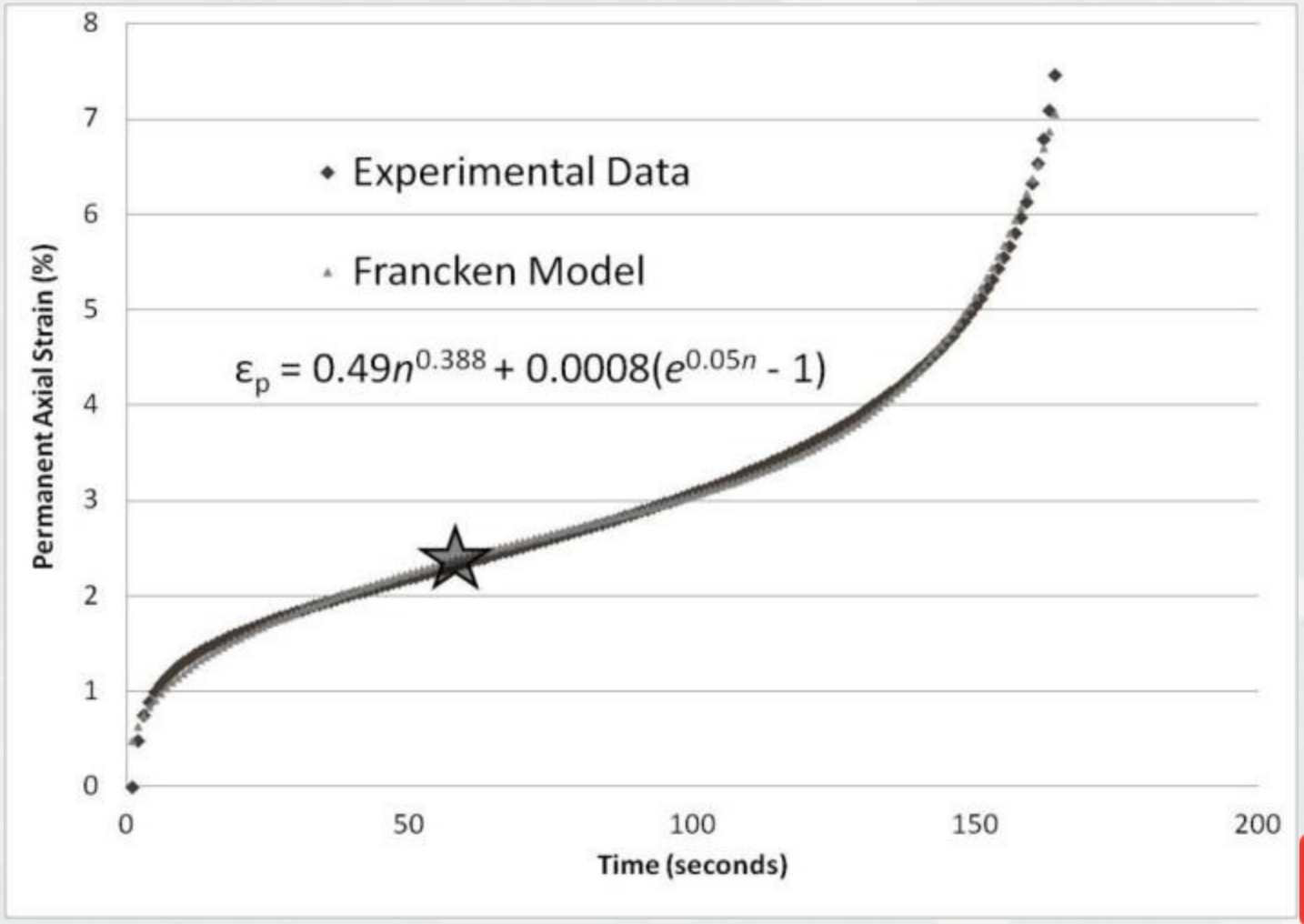


Flow Time

- Permanent Deformation versus Time (static loading condition)
  - Constant load
  - Confining pressure = 40 psi
  - Axial stress = 200 psi
  - Temp = T_{eff} (43°C or 37°C)
  - Francken model fit to data

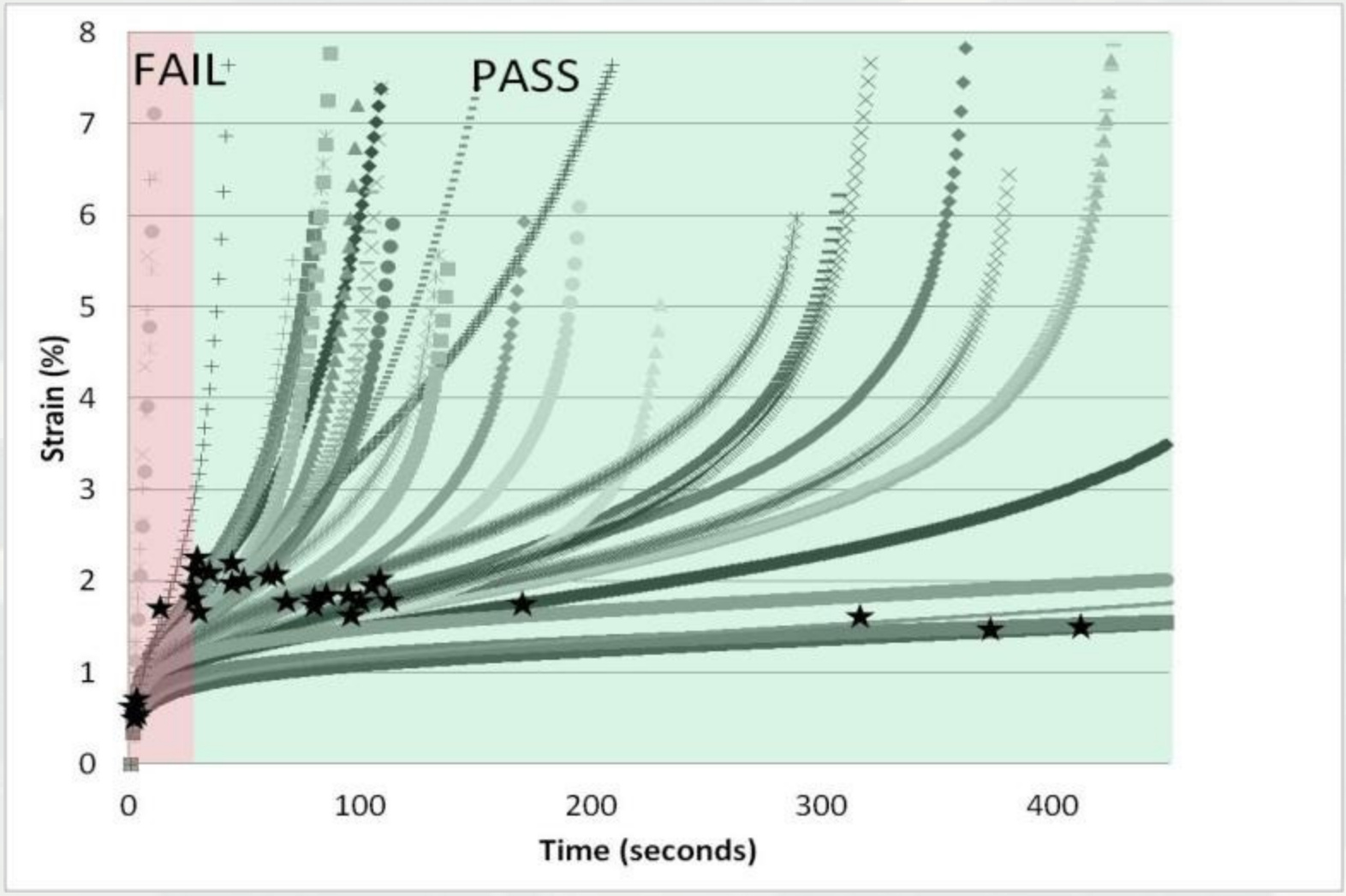
$$\varepsilon_p = An^B + C(e^{Dn} - 1)$$

Example Static Creep Data



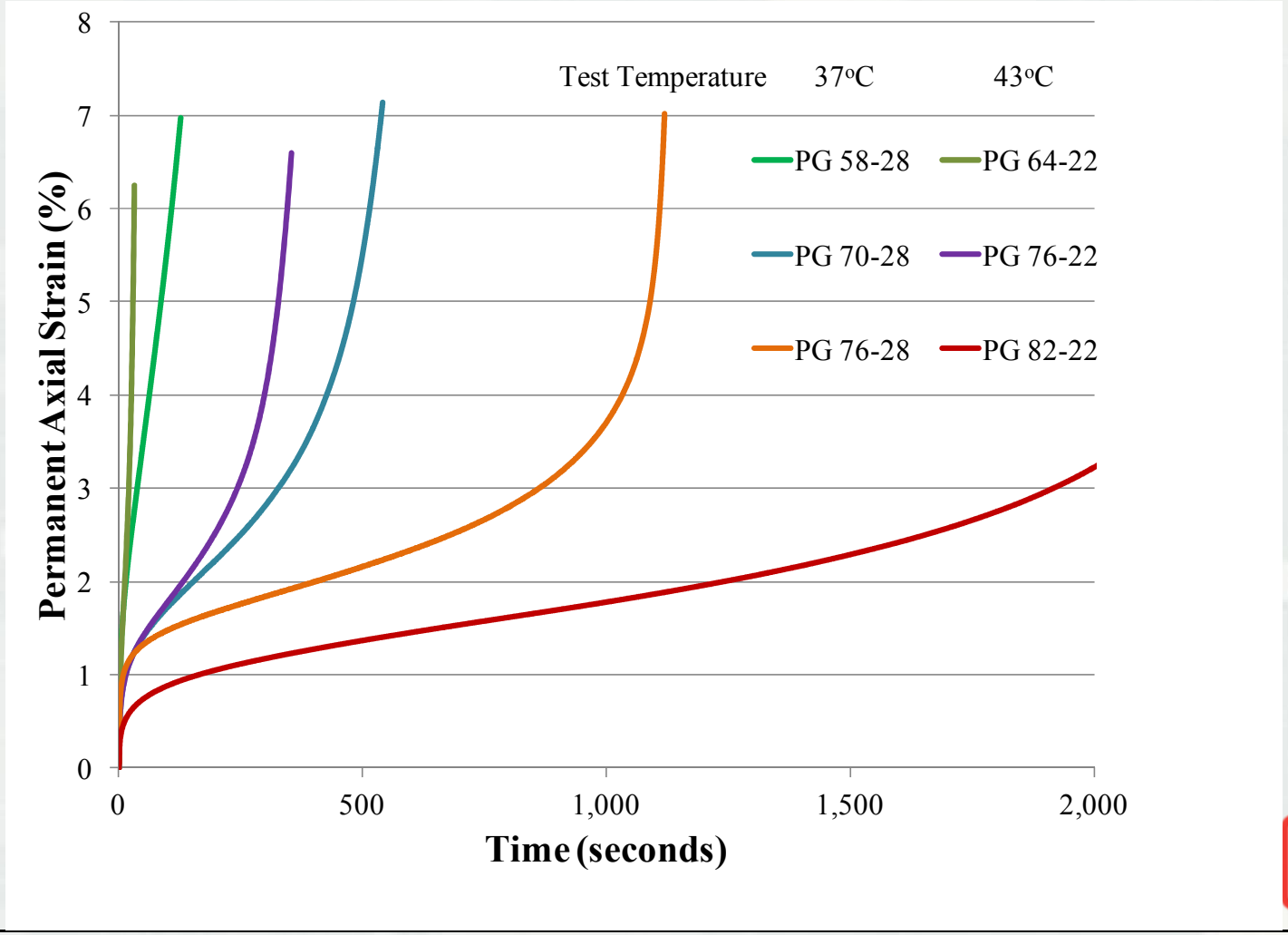
Example Criterion for Flow Time

Phase 1 Results



Influence of Binder on Flow Time

Example from Phase 2

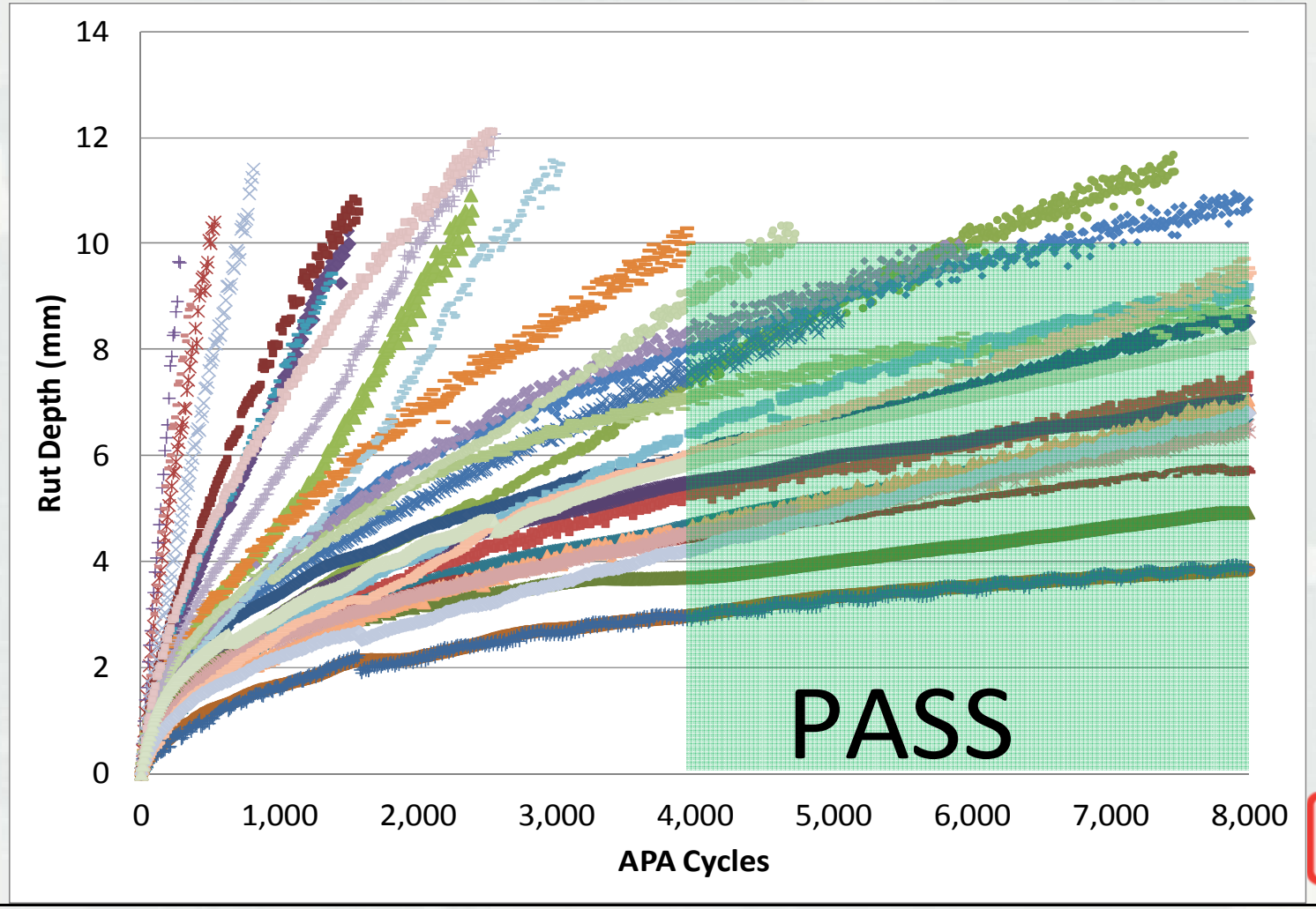


Asphalt Pavement Analyzer (APA)

- Laboratory Wheel Tracking Device
- 250 psi hose pressure
- 8,000 cycles or failure
- Records cumulative rut depth per cycle
- Test temperature based on PG grade

Example Criterion for APA

Phase 1 Results



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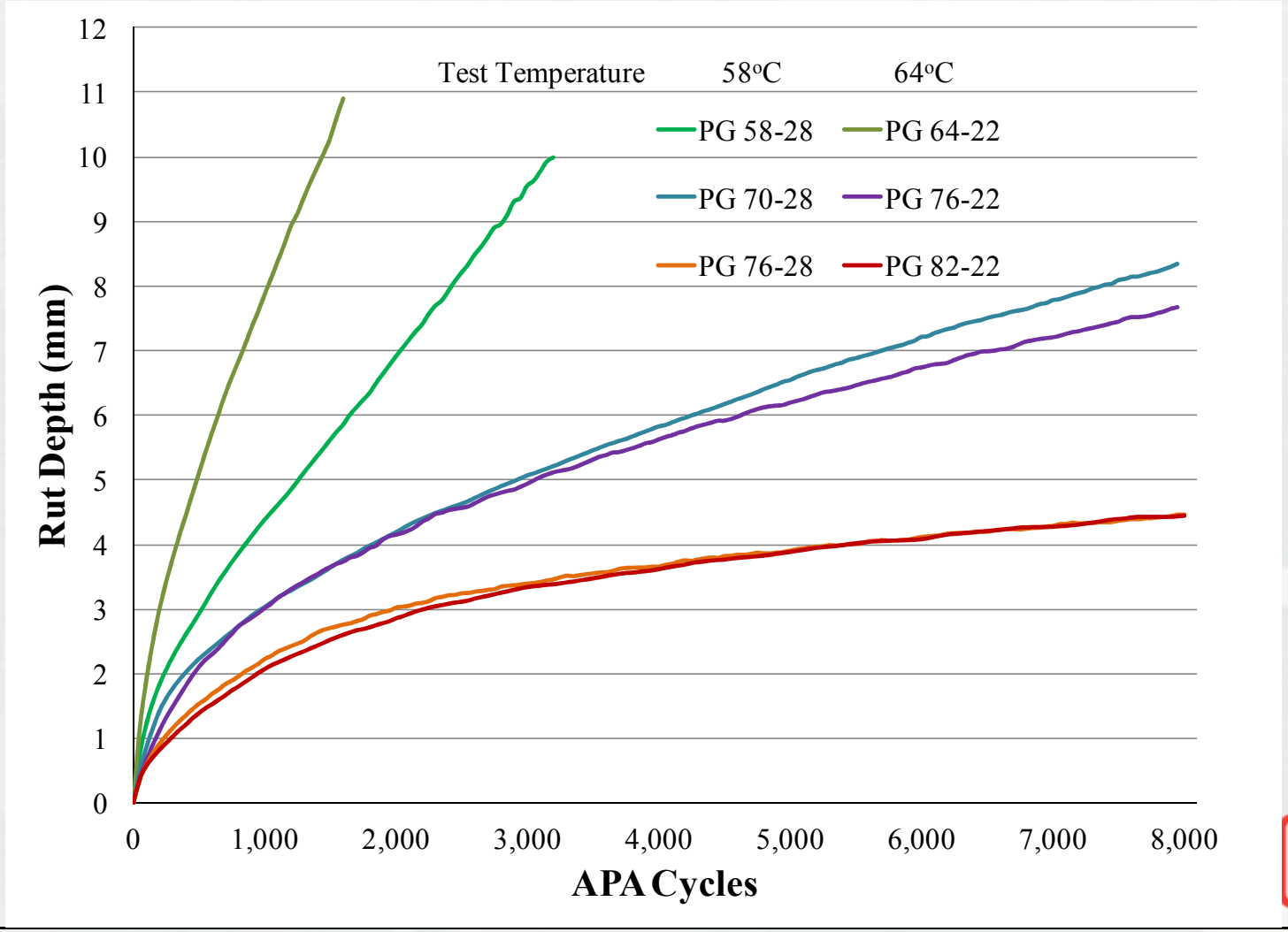
Influence of Binder on APA Results

Example from Phase 2



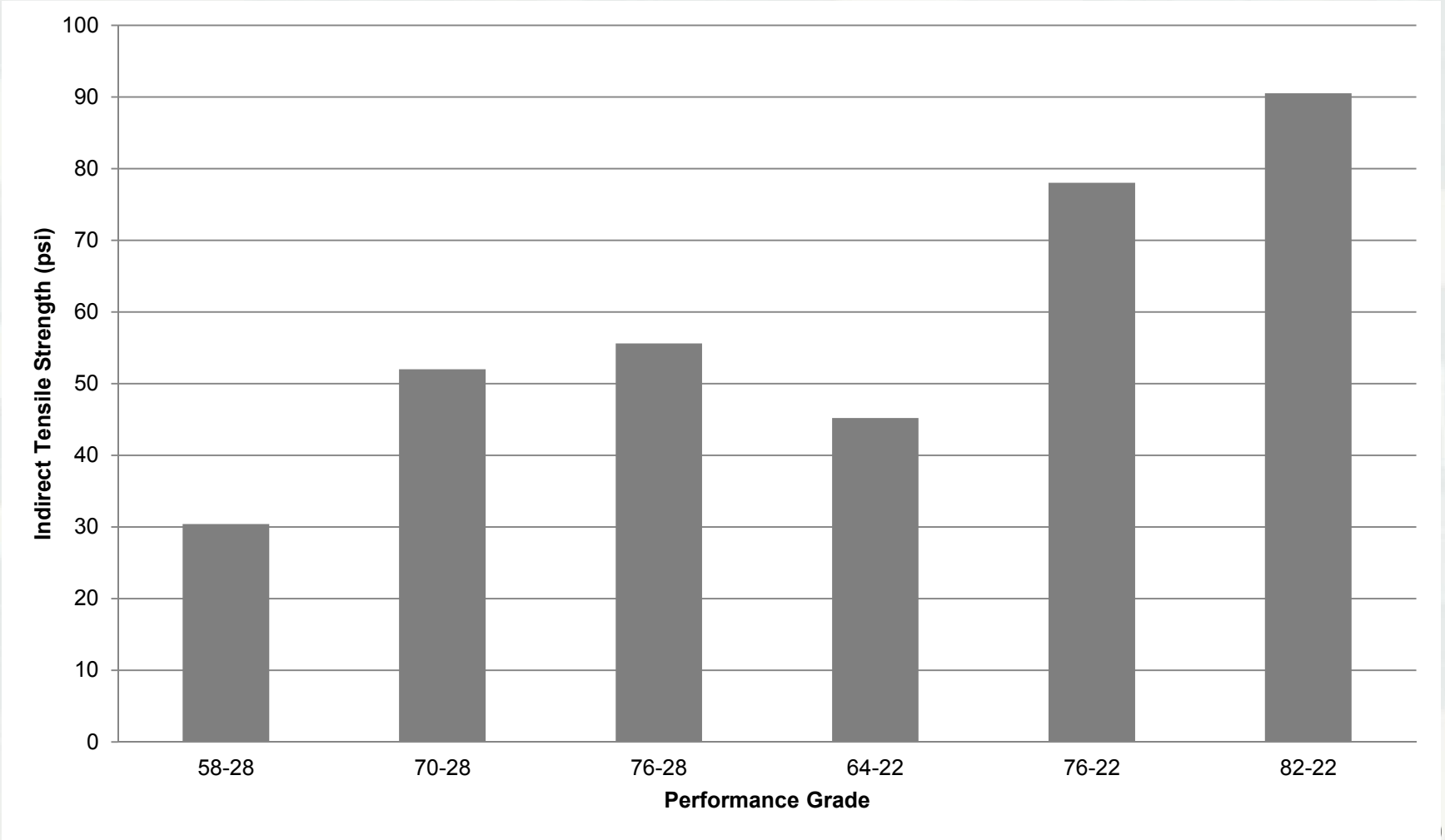
Indirect Tensile Strength

- Test performed at 40°C
- Loading rate of 50 mm/min
- Measure peak load
- Determine IDT

$$S_t = \frac{2000P}{\pi t D}$$

Influence of Binder on IDT Results

Example from Phase 2



Recommendations

- Select projects in each region and validate test acceptance thresholds for mix designs
- Incorporate performance testing requirements in next revision of AC 150/5370-10
- Use pavement management data to review field performance and relate to laboratory test data
- Conduct further investigations for using test as quality control/assurance test
  - Plant-produced mixture
  - Field cores

Acknowledgements

- Federal Aviation Administration
  William J. Hughes Technical Center

- ERDC Materials Testing Center

Questions?

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